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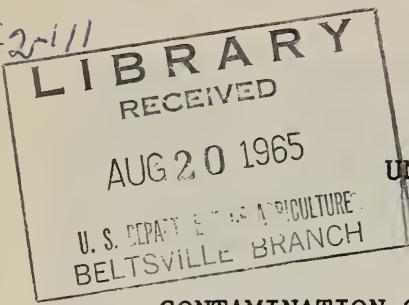
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CONTAMINATION OF COTTON BY LUBRICANTS FROM MECHANICAL HARVESTERS<sup>1/</sup>

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### INTRODUCTION

The picking units of mechanical cotton pickers are composed of numerous rotating steel parts that must be lubricated periodically during harvest operations. Cotton is a very absorbent fiber and is easily contaminated with lubricants from bearings and other parts of the picker when improper servicing procedures are followed.

Oil-lubricated pickers are usually serviced at the end of each day by flushing the bars containing the spindle gears with a lightweight, nondetergent oil. It is customary for grease-lubricated pickers to be serviced every 20 hours of use by applying grease through a fitting on each bar. Oil or grease can be forced out of the spindle bushings of the picker during operations, by either or both spindle rotation and centrifugal force due to bar rotation. Some of the lubricant deposited on the cotton may be from upper drive gears and chains, and from excess amounts left near other grease fittings and bearings.

### PRELIMINARY STUDIES

In a large-scale spinning study in 1958, spindle lubricating oils were suspected of contributing to poor spinning performance of one lot of machine-picked cotton from a local plantation. The study was conducted again in 1959, with the pickers properly serviced. The picking units were inspected with an ultraviolet light before harvesting was begun, and each bale harvested was likewise inspected. The portable light box was equipped with two 15-watt, longwave black lights (3,600 Å.). Because petroleum fluoresces under ultraviolet light, the oil was easily detected; any bale with an unusual amount of oil was rejected. In two experiments, involving over 400 bales, all the lots were spun satisfactorily by the mill.

1/ The research was conducted in cooperation with the Delta Branch, Mississippi Agricultural Experiment Station, Stoneville, and is a contribution to Regional Cotton Mechanization Project S-2.

2/ The first three authors are agricultural engineers, the fourth a cotton technologist, Agricultural Engineering Research Division.

In other experiments in 1959, spinning tests were made on 1/2-bale lots of cotton picked as follows: (1) Immediately after picker servicing at midday, and (2) in late afternoon. An oil-lubricated picker was used. As determined by use of the black lights, only a slight difference in oil content was apparent, and fiber properties were similar--with one exception. Namely, the break factor decreased from the early-picked to the late-afternoon-picked lots.

Following the above tests, laboratory and field tests were conducted at the Delta Branch Station to determine the effects of oil contamination of cotton on spinning performance and fiber properties as related to oil and grease addition to cotton by mechanical pickers.

The tests included the application of oil to cotton by three fillings and flushings of picker spindle bars for about 10 minutes during picking. This practice was not standard (see above) although it has been followed by a large percentage of operators. The results proved the need for following the instruction manuals and recommendations--not only for servicing of the picker but for preservation of fiber properties. Various drier temperatures were employed during ginning. Drying did not affect the oil content of the lint even though smoke from the drier outlets was evident.

## LABORATORY EXPERIMENTS

### 1961 Tests

A series of laboratory tests was performed in 1961 to develop methods of measuring the minute quantity of oil that is deposited on the cotton lint by mechanical pickers. Three cotton samples were collected throughout one day from a mechanical harvester to determine, respectively, the two extremes in range and the medium amount of oil contamination. Methods of quantitative determination of oil and grease on lint by <sup>3/</sup> fluorometric means and reflux extraction have been previously described.<sup>—</sup> Oil was then uniformly sprayed on hand-picked seed cotton in the laboratory at rates comparable to the low, medium and high amounts added by the picker (fig. 1).

Handpicked seed cotton was placed between two wire-mesh screens in an approximately 1-inch layer. Preparatory to finding the percentages by weight of oil contamination in the cotton, the frame and cotton were weighed together and the weight of the cotton (about 8 pounds) was obtained by subtracting the weight of the frame and wire. The screens, three for each rate of spraying, were mechanically pulled in an upright position between two spray guns, which were spraying a mist of SAE 10-weight nondetergent oil (fig. 1). The rates of oil application were given to the cotton by changing the speed of the screen rack. After oil had been applied at each rate, samples of cotton were taken from each of five positions of the screen (five bands each 5 inches wide), starting at the top, to check the oil distribution on the cotton.

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<sup>3/</sup> Wooten, O. B., Parker, R. E., and Shaw, C. S. Detecting and measuring mechanical picker lubricants on cotton. U.S. Agr. Res. Serv., ARS 42-74, 9 pp. November 1962.



Figure 1. Uniform spraying of an established amount of oil on a definite amount of seed cotton.

Table 1 shows, as approximate percentages of fiber by weight, the amounts of added oil distributed. An analysis revealed that the amount of oil deposited was not affected significantly by the vertical position of the cotton in the screen rack. Therefore, oil deposits on the seed cotton were uniform for each of the applications. This was also indicated by observation of the treated bands under ultraviolet light.

Several cotton samples were taken for ginning and analysis from each position at each rate of contamination. The gin used was a 15-saw laboratory gin, with an extractor-feeder and one lint cleaner. The lubricating oil had a detrimental effect on the lint picker and card waste, nep count, yarn strength, yarn break factor, and yarn appearance (table 2). Although all treatments had a relatively low nep content, all oil-treated lots had more neps than the check. There was also an indication that nep count varies directly with the percentage of oil on the lint.

#### 1962 Tests

Laboratory experiments with handpicked cotton were conducted in 1962 in more detail. A uniform mass of 192 pounds of seed cotton was divided into four equal portions; each of three of these were divided into three replicate 16-pound lots for oil spraying and later ginning. The lots of cotton were sprayed with low, medium, and high amounts of oil. The fourth portion provided three 16-pound control lots. The low, medium, and high rates of oil added, measured as a proportion<sup>4/</sup> of fiber, were determined to be 0.22, 0.40, and 0.54 percent, respectively.

4/ See footnote 3 for method of measurement.

Table 1. Amount and effectiveness of distribution of lubricating oil sprayed on handpicked seed cotton held in vertical position in a screen rack, and statistical analyses, 1962<sup>1/</sup> <sup>2/</sup>

Position of cotton	Amount and distribution of oil added to hand picked cotton (by indicated rate of contamination)--according to ratio of contaminant weight to fiber weight--in approximations of contamination in cotton mechanically picked			
	Low Percent	Medium Percent	High Percent	Average Percent
Top 5 inches-----	0.25	0.57	0.67	0.50
5-10 inches from top-----	.37	.41	.65	.48
Middle 5 inches-----	.35	.41	.89	.55
5-10 inches from bottom--	.27	.37	1.19	.61
Bottom 5 inches-----	.19	.33	.69	.40
Average-----	.29	.42	.82	---

Source of variation	df	SS	MS	f	f required at 0.01
Total-----	14	1.0327	--		
Rates-----	2	.7674	0.3837	15.93	8.65
Position-----	4	.0727	.01818	.755	NS
Error-----	8	.1926	.02408	---	--

<sup>1/</sup> SAE 10-weight nondetergent oil applied uniformly on handpicked seed cotton in the laboratory.

<sup>2/</sup> Oil increase approximate. The clean cotton from the field contained 0.35 percent natural oils, waxes, and gums (determined from the check; no oil added). Addition of the percentage oil contamination and 0.35 percent equals the total percentage.

Table 2. Effects on lint-cotton quality (ginning and fiber factors) resulting from adding lubricating oil to handpicked seed cotton, 1962<sup>1/</sup>

Cotton quality factor	Data for lint cotton with indicated percentage of oil			
	0	0.29	0.42	0.82
Upper half mean length---in-----	1.13	1.13	1.13	1.14
Mean length-----in-----	0.92	0.91	0.92	0.93
Uniformity-----index-----	81.0	80.6	81.3	82.0
Picker and card waste--pct-----	8.27	8.77	9.37	8.96
Lint foreign matter content-pct-----	2.84	2.84	2.84	2.84
Neps per 100 sq.in. card web-----	5.0	7.6	8.3	9.7
Yarn strength:				
44's-----lb--	48.9	46.6	46.3	46.4
60's-----lb--	32.0	29.2	29.7	29.2
Yarn break factor-----	2036	1900	1909	1898
Yarn appearance-----index--	113.3	105.0	101.7	103.3

<sup>1/</sup> SAE 10-weight nondetergent oil applied uniformly on handpicked seed cotton in the laboratory.

Table 3 shows test data relating to the three 16-pound lots of undried, handpicked cotton to which oil was applied in the laboratory, also, for comparison, data relating to 16-pound lots of undried, machine-picked cotton. The machine-picked lots were taken from the first, second, and third bales harvested with an oil-lubricated picker following proper servicing. All of the small lots were ginned on a 15-saw laboratory gin, with an extractor-feeder and one lint cleaner.

The data are interpreted as follows:

- (1) All samples were designated as 94.0 in color by the classer, or Strict Low Middling, but the color measurements by colorimeter showed that the Reflectance ( $R_d$ ) was somewhat adversely affected by adding oil to handpicked cotton or by machine picking the cotton;
- (2) The composite grade averaged lower for machine-picked cotton, primarily because of higher trash content;
- (3) There were no important differences in fiber length, strength, break factor, or ends down in spinning;
- (4) There was a trend toward higher picker and card waste with increases in oil content and a suggestion of decreasing yarn strength.

The dried samples showed no decrease in oil content.

#### FIELD EXPERIMENTS

Samples were taken from an oil-lubricated picker in 1961 and 1962, and from a grease-lubricated picker in 1962 and 1963. These lots were ginned and oil content, spinning performance, and fiber properties determined.

##### Oil-Lubricated Picker

According to standard practice, in 1961 and 1962 the spindles of a one-row high-drum picker were flushed overnight with SAE 10-weight oil. The picking units, after being washed with water under high pressure, were allowed to operate for 5 minutes before picking in order to sling out excess oil.

In three consecutive mornings in 1961, cotton was obtained for ginning for spinning tests from a 200-pound lot of seed cotton harvested after no cotton, after one bale, and again after 3 bales had first been harvested. The method of obtaining samples on 3 consecutive days was to eliminate the effect of any possible variation in lubrication. Cotton was ginned each day by use of the following equipment: Tower drier at 200° F., 13-cylinder cleaner, extractor-feeder, and a unit lint cleaner. Ten pounds of lint was extracted from each lot for the spinning tests.

Table 3. Ginning and fiber data relating to cotton samples ginned without drying, from handpicked seed cotton with laboratory application of oil, and from machine-picked bales, 1962<sup>1/</sup>

Test item	Data for oil-contaminated cotton						
	Cotton handpicked, with added oil				Cotton machine-picked <sup>2/</sup>		
	Lacking	Low	Medium	High	1st bale	2d bale	3d bale
Oil content of lint-----pct--	0.18	0.22	0.40	0.54	0.22	0.24	0.20
Classification data <sup>3/</sup>							
Composite grade-----index--	94.0	91.3	94.0	90.0	90.0	90.0	90.0
Color (classer's)-----index--	94.0	94.0	94.0	94.0	94.0	94.0	94.0
Lint color (colorimeter)							
Reflectance-----Rd--	73.0	70.8	70.6	69.2	69.8	69.7	69.3
Yellowness-----+b--	8.6	8.1	8.2	8.4	8.6	8.7	8.6
Lint moisture content-----pct--	5.6	5.8	5.6	5.2	4.4	4.3	4.7
Lint foreign-matter content---pct--	3.19	3.05	3.27	3.08	4.05	3.66	3.95
Fiber data:							
Upper half mean length-----in--	1.06	1.06	1.08	1.08	1.06	1.06	1.06
Mean length-----in--	0.86	0.84	0.86	0.86	0.84	0.84	0.85
Micronaire-----reading-	5.0	5.0	5.1	5.1	5.0	5.0	5.0
Strength-----1,000 p.s.i.--	86	84	84	85	87	85	84
Spinning data:							
Picker and card waste-----pct--	9.7	9.8	10.4	11.0	11.1	10.5	11.0
Neps per 100 sq. in. card web---	8	8	7	1	10	9	8
Yarn strength:							
44's-----1b--	40	40	38	36	38	37	37
60's-----1b--	23	23	23	21	22	21	23
Yarn break factor-----	1553	1553	1550	1417	1496	1486	1513
Ends down-----description <sup>4/</sup> --	Excessive to bs1	Avg. to bs1	Bs1	Excessive to bs1	Avg. to bs1	Bs1	Avg.to bs1

<sup>1/</sup> The data represent averages of 3 replications of 16-pound lots.

<sup>2/</sup> Bales harvested after picker was serviced.

<sup>3/</sup> The staple length of all samples was 1-1/16-inches.

<sup>4/</sup> The ends-down information was supplied in descriptive terms without numerical values and, therefore, could not be averaged; bs1 = beyond spinnable limits.

There was little difference in the total oil in the several lots, with the percentage ranging from 0.30 to 0.47. There was essentially no difference in fibrograph length and uniformity. Picker and card waste was slightly higher for cotton of higher oil content.

The nep content of all the cotton was low, but the oil-contaminated lots were slightly higher in nep count than the check lot. Yarn strength and appearance of the check lot were better than those of the oil-contaminated lots. The yarn strength and appearance of the oil-contaminated lots, however, showed no important differences.

Table 4 shows that the maximum oil contamination by the picker was experienced on the first 50 pounds of seed cotton harvested. Oil contamination gradually dropped during the harvesting of the first bale and remained constant thereafter.

Table 4. Lubricating-oil contamination of various amounts of seed cotton harvested by a mechanical picker throughout the day, as determined after ginning, 1961

Cotton harvested	Petroleum oil found on lint <sup>1/</sup>
Pounds	Percent
50	0.280
100	.235
150	.090
200	.130
1450	.075
1500	.070
1550	.140
1600	.095
4050	.135
4100	.090
4150	.100
4200	.050

<sup>1/</sup> Approximate. Handpicked check in the same field contained 0.08 percent natural oils, waxes, and gums. Addition of the percentage oil contamination and 0.08 percent equals the total percentage.

In the 1962 experiment with an oil-lubricated picker, in three consecutive mornings the first three bales were harvested immediately after servicing of the picker. In this year larger lots of cotton were collected to provide 100-pound ginning samples. The extent of oil-lubricant contamination and the effect of artificial drying on the oil content of the lint were studied. The seed cotton was ginned in a large gin plant with three replications each of dried and undried cotton from each bale.

All lots were cleaned and ginned with the following machinery arrangement as normally recommended for machine-picked cotton: 6-cylinder cleaner, burr machine with stick remover attachment, 7-cylinder cleaner, extractor-feeder, and two lint cleaners.

The dried lots included the 24-shelf tower drier at 225° F.

Various data, including those on oil content, classification, foreign matter, fiber, and spinning, for both dried and undried lots, are presented in table 5. The data show that very little oil was added to the cotton by the normally used lubricating oil of the mechanical picker. Very little difference was found between the oil contents of the lint representing the three dried bales and of that representing the three undried bales. Drying at the gin did not remove any of the oil. The oil contents averaged slightly higher for the dried bales, 0.21 percent compared with 0.19 percent for the undried bales.

A study of the classification, foreign matter, fiber, and spinning data shows that the differences encountered are only the normal ones already established for dried as compared with undried cotton. The differences, therefore, are not caused by differences in oil content of the cotton. For example, the classer's grade values of the three undried bales were essentially the same, that is, 96.7, 97.0, and 97.7, or Strict Low Middling plus; but all three of the dried bales cleaned better as is normal, because of drying--each being 100, or Middling, in grade value.

#### Grease-Lubricated Picker

The final phase of the study on lubricant contamination of cotton involved the use of mechanical pickers whose spindles were lubricated with grease.

In the 1962 tests, 1-pound representative samples of seed cotton were taken from the picker basket, beginning immediately after greasing the spindles and continuing each hour thereafter. Handpicked samples were collected from the field at the same time. Because of a limited supply of cotton of the same variety, only two replications were made, the first test being continued for 9 hours at test and the second for 16 hours.

In 1963, 16 seed-cotton samples of 35-pounds each were taken for quality determinations. The first sample was taken immediately after greasing and the others after 1, 3, 5, 10, and 15 hours of harvesting. Three replications of this test were made during 3 consecutive weeks of the harvest season. A hand-picked (35-pound) control lot was obtained at each harvest each week.

Table 5. Ginning and fiber data relating to first, second, and third bales  
of cotton harvested by oil-lubricated picker, after servicing, 1962<sup>1/</sup>

Test item	Data for oil-contaminated machine-harvested cotton bales after picker was initially serviced					
	1st bale		2d bale		3d bale	
	Undried	Dried	Undried	Dried	Undried	Dried
Oil content of lint-----pct--	0.22	0.22	0.19	0.21	0.16	0.19
Classification: <sup>2/</sup>						
Grade-----index--	96.7	100.0	97.0	100.0	97.7	100.0
Moisture content:						
Wagon sample-----pct--	10.6	10.3	9.4	9.1	9.7	9.1
Feeder sample-----pct--	10.4	8.4	9.1	7.9	9.4	7.6
Lint sample-----pct--	8.6	5.8	8.3	5.8	8.1	5.5
Foreign matter content:						
Wagon sample-----pct--	6.8	6.1	6.5	7.4	8.0	7.4
Feeder sample-----pct--	2.0	1.5	2.0	1.7	1.9	1.4
Lint-----pct--	2.38	1.38	2.26	1.32	2.23	1.46
Fiber data:						
Upper half mean length-----in--	1.09	1.07	1.10	1.06	1.08	1.06
Mean length-----in--	0.88	0.84	0.87	0.84	0.86	0.84
Micronaire-----reading--	4.8	4.8	4.8	4.8	4.7	4.8
Strength-----1,000 p.s.i.--	84	83	86	86	86	87
Raw stock lint color:						
Reflectance-----Rd--	72.4	72.8	73.0	74.7	73.2	74.4
Yellowness-----+b--	9.1	9.3	8.8	9.1	8.8	9.3
Spinning data:						
Picker and card waste-----pct--	8.7	7.2	7.9	7.2	7.8	7.0
Neps per 100 sq. in. card web---	13	11	10	13	11	11
Yarn strength:						
44's-----lb--	48	41	46	43	45	42
60's-----lb--	27	24	28	25	27	24
Yarn break factor-----	1803	1581	1835	1722	1807	1674
Ends down-----description <sup>3/</sup> --	Low to avg.	Low to excess-	Low	Low to bsl	Low to avg.	Low to bsl
		sive				

<sup>1/</sup> The data represent averages of 3 replications of 100-pound samples.

<sup>2/</sup> The staple length of all samples was 1-1/16 inches.

<sup>3/</sup> See footnote 4 of table 3.

Grease contamination results for both years are presented graphically in figure 2. The curves represent the amount of oil (percent by weight) extracted

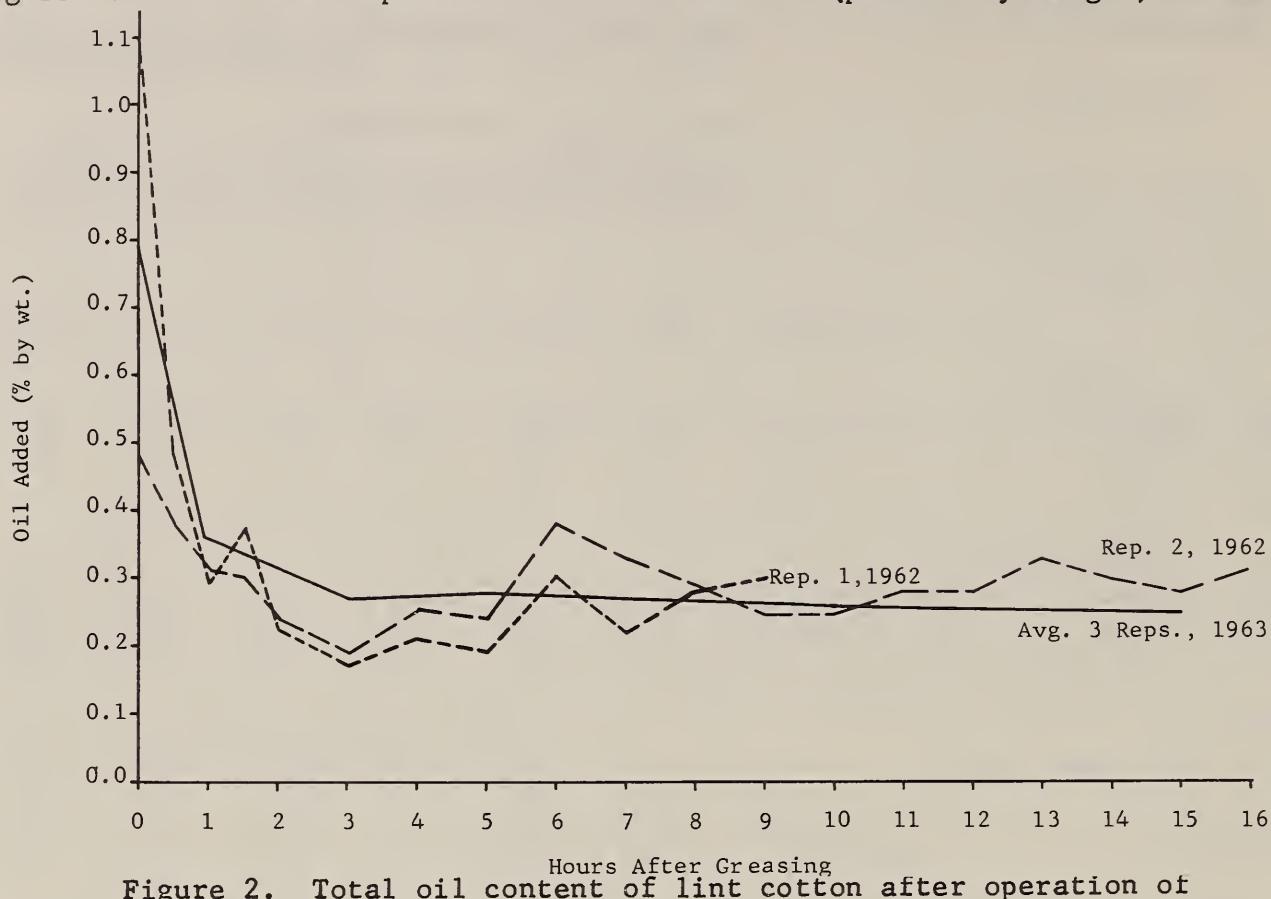


Figure 2. Total oil content of lint cotton after operation of grease-lubricated pickers up to 16 hours after servicing.

from the lint cotton samples, which included some natural oils, waxes, and gums. The hand-picked checks from the two replications in 1962 contained 0.18 and 0.19 percent of oil, respectively, in the form of natural oils, etc.; the three checks in 1963 averaged 0.24 percent. Oil added to the lint by mechanical pickers using grease for spindle lubrication ranged from 0.29 to 0.92 percent by weight immediately after greasing. The oil content decreased during the first 3 hours and remained constant thereafter. The picker was serviced according to the manufacturer's instructions preceding the 9-and 16-hour runs and each of the three 15-hour runs.

In the 1963 test, the 35-pound samples were cleaned and ginned in a pilot plant with the following equipment: Multipath drier, 6-cylinder cleaner, stick remover, extractor-feeder, and two lint cleaners. At the gin, adequate samples were taken to determine classification, moisture, foreign matter, fiber color, and for spinning tests, and to determine oil content of lint. The data are presented in table 6.

Table 6. Ginning and fiber data relating to cotton harvested by grease-lubricated picker, at various times after servicing, 1963<sup>1/</sup>

Test item	Clean hand- picked cotton	Data for grease-contaminated machine-harvested cotton with time lapse to particular test harvest after picker was serviced					
		None	1 hr.	3 hrs.	5 hrs.	10 hrs.	15 hrs.
Oil content of lint-----pct--	0.24	0.79	0.36	0.27	0.28	0.26	0.25
Classification: <sup>2/</sup>							
Grade-----index--	104.0	100.0	100.0	100.0	100.9	100.9	101.3
Moisture content:							
Wagon sample-----pct--	7.0	8.2	7.6	7.4	7.7	7.9	7.7
Lint sample-----pct--	4.4	4.4	4.4	4.5	4.6	4.6	4.5
Foreign matter content:							
Wagon sample-----pct--	1.0	4.2	3.6	4.2	3.8	3.6	4.7
Feeder sample-----pct--	0.3	0.5	0.4	0.4	0.5	0.5	0.5
Lint-----pct--	1.06	1.29	1.42	1.43	1.38	1.46	1.50
Fiber data:							
Span length:							
50 percent-----in---	0.50	0.48	0.48	0.48	0.49	0.49	0.50
2.5 percent-----in---	1.09	1.09	1.08	1.08	1.08	1.08	1.09
Uniformity-----ratio--	46.0	44.3	44.3	44.0	45.0	45.6	46.0
Raw stock lint color:							
Reflectance-----Rd--	79.0	70.7	74.8	76.3	76.2	76.6	76.4
Yellowness-----+b--	8.1	8.4	8.1	8.3	8.5	8.4	8.4
Spinning data:							
Picker and card waste-----pct--	7.0	9.4	7.6	7.6	8.0	7.8	7.6
Neps per 100 sq. in. card web--	17	24	23	23	25	20	20
Yarn strength:							
44's-----1b--	42	37	40	42	43	43	43
60's-----1b--	25	22	24	25	26	26	26
Yarn break factor-----	1684	1481	1617	1691	1716	1729	1736
Ends down-----description <sup>3/</sup>	Low	Avg.	Low	Low	Low	Low	Low

<sup>1/</sup> The data represent averages of 3 replications of 35-pound samples.

<sup>2/</sup> The staple length of all samples was 1-1/32 inches.

<sup>3/</sup> See footnote 4 of table 3.

All of the handpicked cotton classed Strict Middling 1-1/32 inch. The lint samples representing the zero, 1-hour, and 3-hour periods of time lapse after servicing of the picker all classed Middling 1-1/32 inch. The samples for the 5-, 10-, and 15-hour periods also had a market value of Middling 1-1/32 inch, but they were slightly higher in grade index value as compared with those of the earlier periods. Both the handpicked and machine-picked seed cotton was dry when picked; but, as is normal, the machine-picked cotton averaged about 1 percent higher in wagon sample moisture content than the handpicked cotton. At ginning, the moisture content of the lint was kept uniformly at about 4.5 percent for all lots.

There was essentially no difference in the fiber length of the cotton representing the handpicked or any of the machine-picked lots. As is normal, neps and yarn appearance and picker- and card-waste results were somewhat better for the handpicked than for the machine-picked cotton. It is very noticeable that the cotton representing the zero period following servicing of the picker averaged 9.4 percent in picker and card waste but that the other machine-picked lots had a combined average of 7.7 percent. Also important, the zero-period spin lot had a yarn appearance index of 92 as compared with an average of 99 for all the other machine-picked lots. A review of the color-test results shows that color values of the cotton progressively improved with increases of time lapse up to 3 hours following servicing of the picker.

#### CONCLUSIONS

1. Both oil- and grease-lubricated cotton pickers add more lubricant to cotton during the first hour of operation after servicing than at any other time.
2. From 1 to 3 hours after servicing the picker, lubricant contamination of cotton drops to a negligible level.
3. Excessive oil adversely affects the yarn strength, yarn appearance, yarn break factor, grade, color, ends down, nep count, and picker and card waste.
4. Oil contamination of seed cotton does not affect the foreign matter content or staple length of the lint.
5. Seed cotton driers at the gin do not remove enough oil to prevent the lowering of fiber properties, even though smoke is evident at the drier outlets.

#### RECOMMENDATIONS

1. Lubrication of the picker should be done as illustrated in the instruction manual for the machine.
2. An oil-lubricated picker should not be flushed with oil during the harvest day unless sufficient time is allowed for the oil to be drained through. The picking unit should be rotated at full throttle with the doors open for a short period of time before resuming picking. This will throw excess oil off the spindles. Washing the picking unit with a high-pressure hose immediately after lubrication is also a good practice.
3. Only the proper amount of lubricant should be applied to grease-lubricated machines, since excess lubricant will be quickly dissipated.
4. Pickers should be checked closely after servicing, and all excess lubricant removed before harvesting begins.